Exercise 5.17 Figure 5.15 on page 217 shows a simplified redundant communication network between an unmanned spacecraft (*sc*) and a ground control center (*gc*). There are two indirect high-bandwidth (high-gain) links that are relayed through satellites (*s*1, *s*2) to different ground antennae (*a*1, *a*2). Furthermore, there is a direct, low-bandwidth (low-gain) link between the ground control center's antenna (*a*3) and the spacecraft. The low-gain link is affected by atmospheric disturbances – it works if there are no disturbances (*no_dist*) – and the spacecraft's low-gain transmitter (*sc_lg*) and antenna 3 are okay. The high-gain links always work if the spacecraft's high-gain transmitter (*sc_hg*), the satellites' antennae (*s*1*_ant*, *s*2*_ant*), the satellites' transmitters (*s*1*_trans*, *s*2*_trans*), and the ground antennae (*a*1, *a*2) are okay.

To keep matters simple, we consider only messages from the spacecraft going through these channels to the ground control center.

The following knowledge base formalizes the part of the communication network we are interested in:

$$send\_signal\_lg\_sc \leftarrow ok\_sc\_lg \wedge alive\_sc.$$
$$send\_signal\_hg\_sc \leftarrow ok\_sc\_hg \wedge alive\_sc.$$
$$get\_signal\_s1 \leftarrow send\_signal\_hg\_sc \wedge ok\_s1\_ant.$$
$$get\_signal\_s2 \leftarrow send\_signal\_hg\_sc \wedge ok\_s2\_ant.$$
$$send\_signal\_s1 \leftarrow get\_signal\_s1 \wedge ok\_s1\_trans.$$
$$send\_signal\_s2 \leftarrow get\_signal\_s2 \wedge ok\_s2\_trans.$$
$$get\_signal\_gc \leftarrow send\_signal\_s1 \wedge ok\_a1.$$
$$get\_signal\_gc \leftarrow send\_signal\_s2 \wedge ok\_a2.$$
$$get\_signal\_gc \leftarrow send\_signal\_lg\_sc \wedge ok\_a3 \wedge no\_dist.$$

Ground control is worried, because it has not received a signal from the spacecraft (*no_signal_gc*). It knows for sure that all ground antennae are okay (i.e., *ok_a*1, *ok_a*2, and *ok_a*3) and satellite *s*1's transmitter is ok (*ok_s*1*_trans*). It is not sure about the state of the spacecraft, its transmitters, the satellites' antennae, *s*2's transmitter, and atmospheric disturbances.

(a) Specify a set of assumables and an integrity constraint that model the situation.

(b) Using the assumables and the integrity constraints from part (a), what is the set of minimal conflicts?

(c) What is the consistency-based diagnosis for the given situation? In other words, what are the possible combinations of violated assumptions that could account for why the control center cannot receive a signal from the spacecraft?

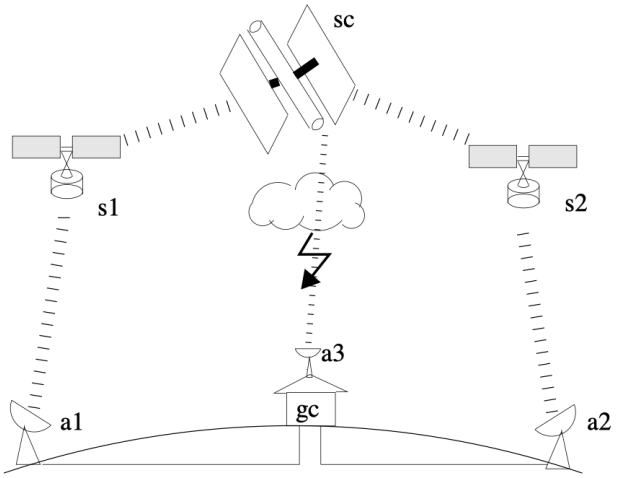

Figure 5.4: A space communication network